Integration of Models in a Risk Assessment Framework – Regional Air Impact Modeling Initiative (RAIMI)

U.S. EPA Region 6

Multimedia Planning and Permitting Division

July 2003

COMMUNITY LEVEL ASSESSMENTS - REGIONAL PERSPECTIVE

- Significant Intermingling of Industry and Neighborhoods
- National Scale Studies Continue to Flag Problems in Several Region 6 States
- Scale of Issues Too Large to Ignore
- Holistic Answer Needed to Bottom-Line Questions
- Multi-program/Cross Media
- Receptor-based Approach

REGION 6'S *SOLUTION* FOR DEVELOPING CAPABILITIES TO DO LOCALIZED ASSESSMENTS

Regional Air Impact Modeling Initiative (RAIMI)

- Risk-based Prioritization Tool Set and Project Platform to Develop Multi-media Solutions to Environmental Problems

REGIONAL AIR IMPACT MODELING INITIATIVE (RAIMI)

Design Strategy considerations

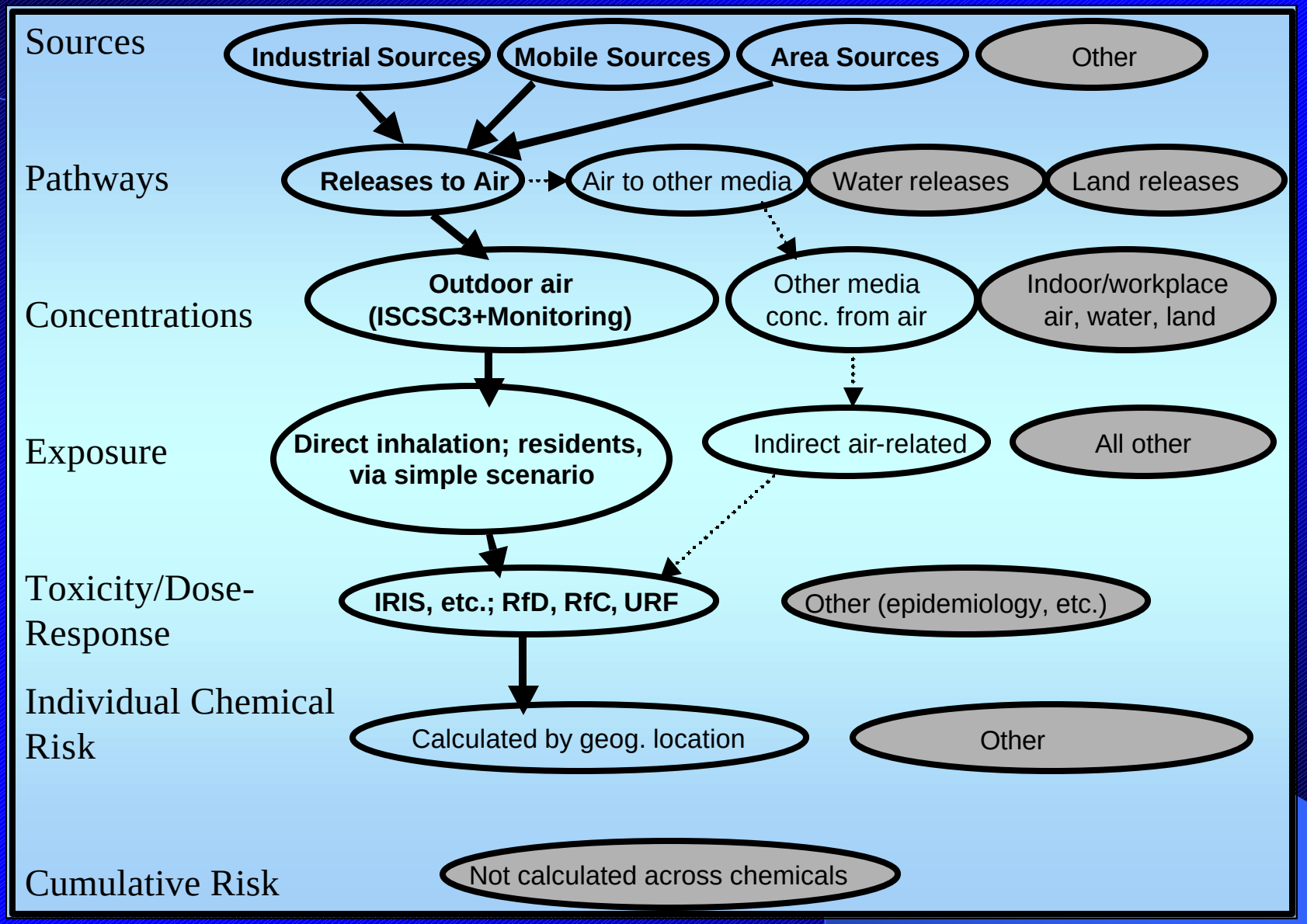
- Provide A **Consistent Means By Which Permitting Authorities Could Account For And Assess Potential Health Effects** To Multiple Contaminants From Multiple Sources
- **Evaluate And Demonstrate Protectiveness Of Cross Program (e.g., RCRA, CAA, Exempt) Permitting Decisions** And Support Holistic, Tailored Permit Strategies
- **Calculate And Track Risks From Literally Hundreds Of Sources And Contaminants**
- Provide Necessary Information To **Prioritize And Identify Solutions**, For Sources Resulting In Unacceptable Risks, At A **Community Level Of Resolution**, And Generated In A Fully Transparent Fashion Such That **Risk Levels Are Traceable To Each Contaminant, Each Pathway, And Each Source**

DETERMINING PROJECT OBJECTIVES

Guiding Factors in Determining Project Objectives - USABILITY and UTILITY

- Defensible-relies on approved methods
- Numerically correct and consistent
- Time efficient (month vs. year timeframe to complete)
- Cost efficient (tens of thousands vs. hundreds of thousands)
- Flexible-analyze variations/what if's
- Provides interim utility (useful data for trending, flags potential problems, etc.)
- Directly applicable to end user's needs
- Directly supports solution implementation

RAIMI – Conceptual Model



Regional Air Impact Modeling Initiative (RAIMI)

Emissions Characterization Component

- Acquire necessary data and inputs to complete air- and risk-modeling components
- Obtain data resolution and quality to support source-specific prioritization and decision making
- Identifies and tracks key source sectors to support trending analysis
- Supports sector/source profiling (such as source, contaminant, exposure pathway, facility)
- Manages data cost effectively to ensure integrity of modeled emissions/source data available to unique modeled sources
- Identifies and characterizes data gaps

State and Federal Emission Inventories

Database Digestion / Processing Tools

Air Dispersion Modeling Component

- Supports standardized and consistent methodologies for the assessment and evaluation of risk and hazard from multiple contaminants, multiple facilities, and hundreds of sources, as well as the level of resolution to perform localized assessments
- Provides data necessary for risk modeling and supports risk-based source-specific decision making
- Accommodates flexibility in the design of site-specific risk evaluation and management scenarios without regressing air modeling
- Uses current procedure, regulatory guidance, and readily available data
- Implements single pass modeling approach

Input-processor Air Dispersion Model Results (AERMOD)

Execute Air Dispersion Model (ISCST3)

Pre-processor Air Modeling Inputs Surface Data SCRAM Data MPRM Stage 1 and 2 MAP

Risk Modeling Component

Risk-MAP

- Overall goals is to quickly and accurately assess as well as be useful to day-to-day processing, planning, and collaboration activities
- Overall goals is a level of resolution and accessibility to serve as a tool to stakeholders deciding to evaluate, implement, and track solutions
- Provides a standardized and consistent access to conduct risk-based assessments and prioritization of multiple emission sources, multiple contaminants, from multiple facilities
- Offers significant flexibility to modify or replace risk modeling inputs to tailor risk modeling to site-specific conditions and concerns
- Provides readily accessible risk-based prioritization tools and platform that address multi-media solutions to environmental problems
- Calculates and tracks perceived risks from hundreds of sources to fully incorporate concerns
- Uses "pure" GIS Architecture

MAP Data Layers

Aerial Photos

LULC

Topographic

Census

Spatial Data Processing

- Performs source geo-coordinates to address NAD 27 vs 83 coordinate system issues, identify source coordinates,
- Identifies and incorporates readily available and current mapping information (such as facility boundaries)
- Offers functionality to update, overlay and combine map processes

Source Manager

Emission Tracking Database (ETD)

- Includes Risk-MAP released database repository and management system that efficiently manages and stores source-specific information (and associated emissions) required to perform air dispersion and risk modeling
- Offers functionality to calculate risk, develop security protocols, and user- and user-based record access

Node Attribute Index Table (NAT)

- Released database table designed to efficiently store and access air dispersion modeling results

Exposure Analysis Manager

- Supports receptor-based approach
- Implements HHRAP Exposure Defaults (such as inhalation and consumption rate, exposure duration)
- Applies "simplified" exposure scenarios
- Implements HHRAP fate and transport and toxicity processes
- Offers flexibility to add or remove exposure pathways
- Provides options to include site-specific data at a regional, neighborhood, or location-specific level
- Supports advanced risk modeling functions through flexibility to design, update, and track risk assessment inputs (such as sensitivity analysis, "what if scenarios", boundary analysis)

Results Manager

- Provides access to risk results and results management functionality
- Results can be saved or queried for exclusive profiling to quickly identify contributing sources, concentrations, area of concern, etc
- Process results in multiple formats including:

Graphs

Tables

Charts

Maps

- Supports multi-user data applications to perform fate/transport, further data analysis, enable direct access within the GIS Risk-MAP platform
- Supports expanded processes and graphical evaluations of risk results

Solutions Tracking and Implementation Component

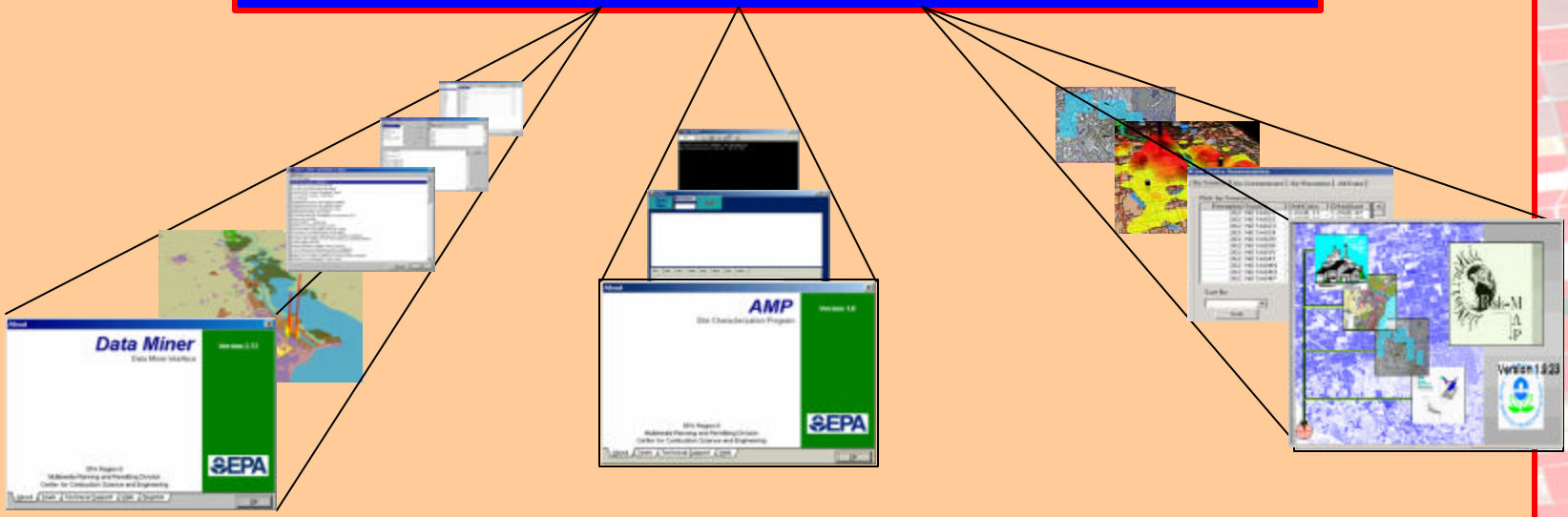
- Prioritize Sources – Select source type, concentration, neighborhood, facility
- Verification – Verify Source location, emission profile, toxicity factors
- Refinements – Identify data gaps, secondary processes, boundary analysis
- Legal Review – Document permit status, source status, operating conditions
- Facility Involvement – Solicit facility data, exposure questions
- Identify Risk Management Options – Document acceptable risk levels, review Options
- Implement and Track Solution and Outcomes – Perform modeling analysis, support GPRA goals

Results Communication / Presentation

Report

Web

RAIMI Tools and Capabilities



Emissions Inventories

- **State/ Federal Databases** (e.g., PSDB, NTI, TRI)
- **Database Digestion / Formatting tools** – Data Miner
- **Emissions Visualization**
- **Emissions Tracking Database** (ETD)

Air Dispersion Modeling

- **Pre-processing tools** – AMP
- **Unit Emission Rate**
- **Universal Grid**

Results and Solutions Management

- **Source/Unit Specific**
- **GIS Platform** (Risk-MAP) **enhances**:
  - risk communication
  - risk management
  - data gap evaluation
- **Bounding/Trending**
- **Waste Minimization**

EMISSIONS CHARACTERIZATION

Example Objectives Specific to Emissions Characterization

- Obtain necessary data as inputs to complete air and risk modeling;
- Obtain resolution and quality of data to support source-specific prioritization and decision making;
- Identify and track key source attributes to support trending analysis
- Support attribution profiling (source/contaminant/exposure pathway)

EMISSIONS CHARACTERIZATION

Emissions Data Sources

Potential Data Source	Maintained By	Format
National Emissions Inventory (NEI)	U.S.EPA	Digital
Toxic Release Inventory (TRI)	U.S. EPA	Digital
Aerometric Information Retrieval System (AIRS)	U.S. EPA	Digital
RCRA Hazardous Waste Files	U.S. EPA and State	Hard copy
RCRA Information System	U.S. EPA	Digital
State Emissions Inventory	State	Digital
New Source Review Permit Files	State	Hard copy
Title V Permit Applications Table 1(a) forms	State	Hard copy
Facility files and records	Facility	Hard copy

EMISSIONS CHARACTERIZATION

Emissions Data Needs

	Modeling	
	Air	Risk
Location (North American Datum 1983)	✔	
Source dimensions (diameter or area)	✔	
Elevation (base and release height)	✔	
Exit gas velocity	✔	
Exit gas temperature	✔	
Control device information	✔	
Particle size distribution and density	✔	
Contaminant name and CAS number		✔
Speciated emissions rate		✔

RAIMI COMPONENTS

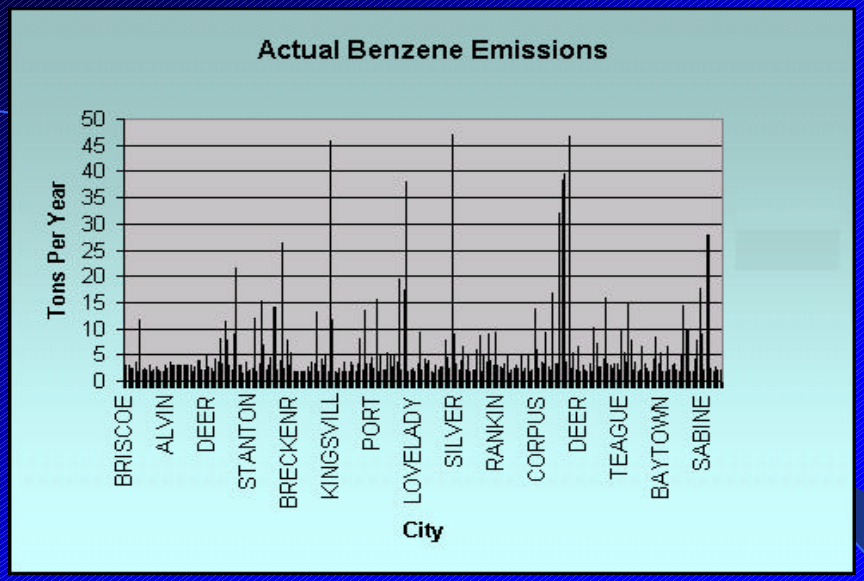
Emissions Characterization Component

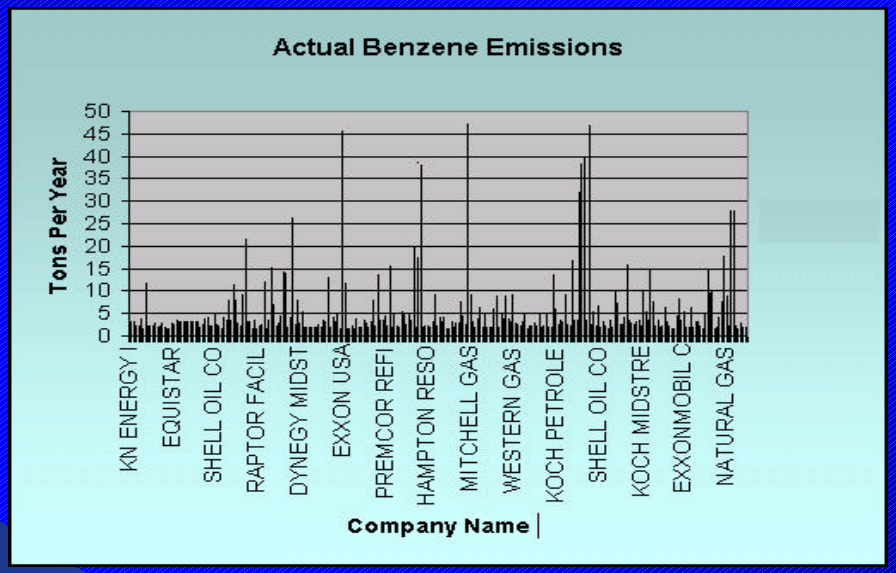
DATA MINER

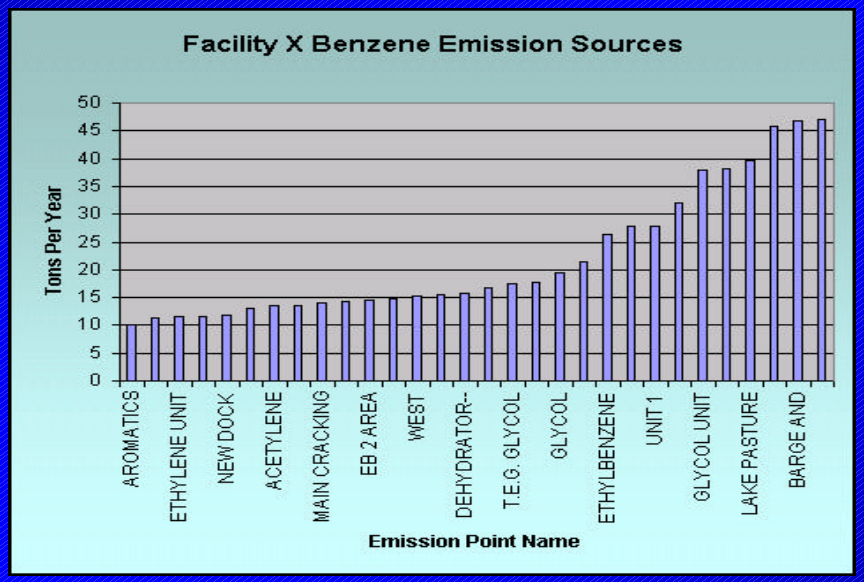
- Emissions data query tool
- Used to extract data from extremely large emissions databases

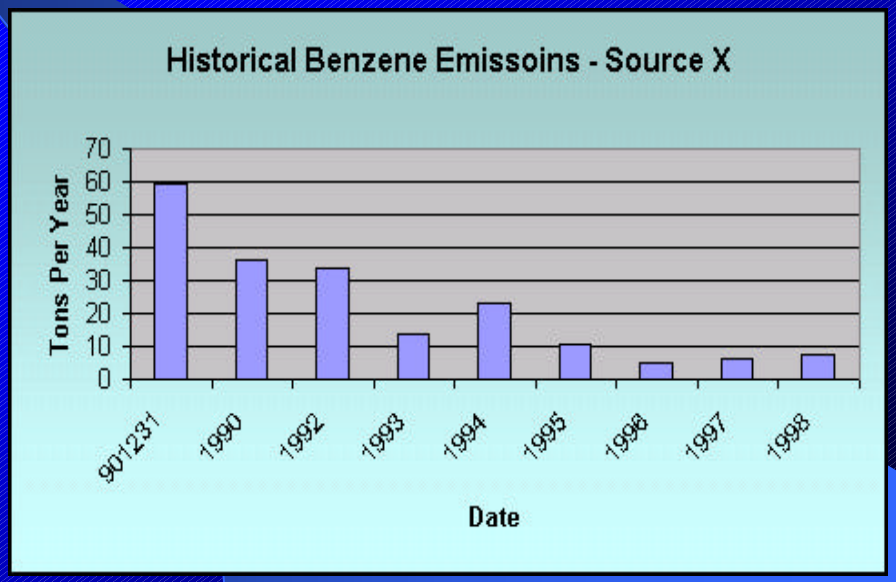
- Exports data directly to GIS platform
- Useful for visually displaying emissions data

Data Miner – Example Capabilities

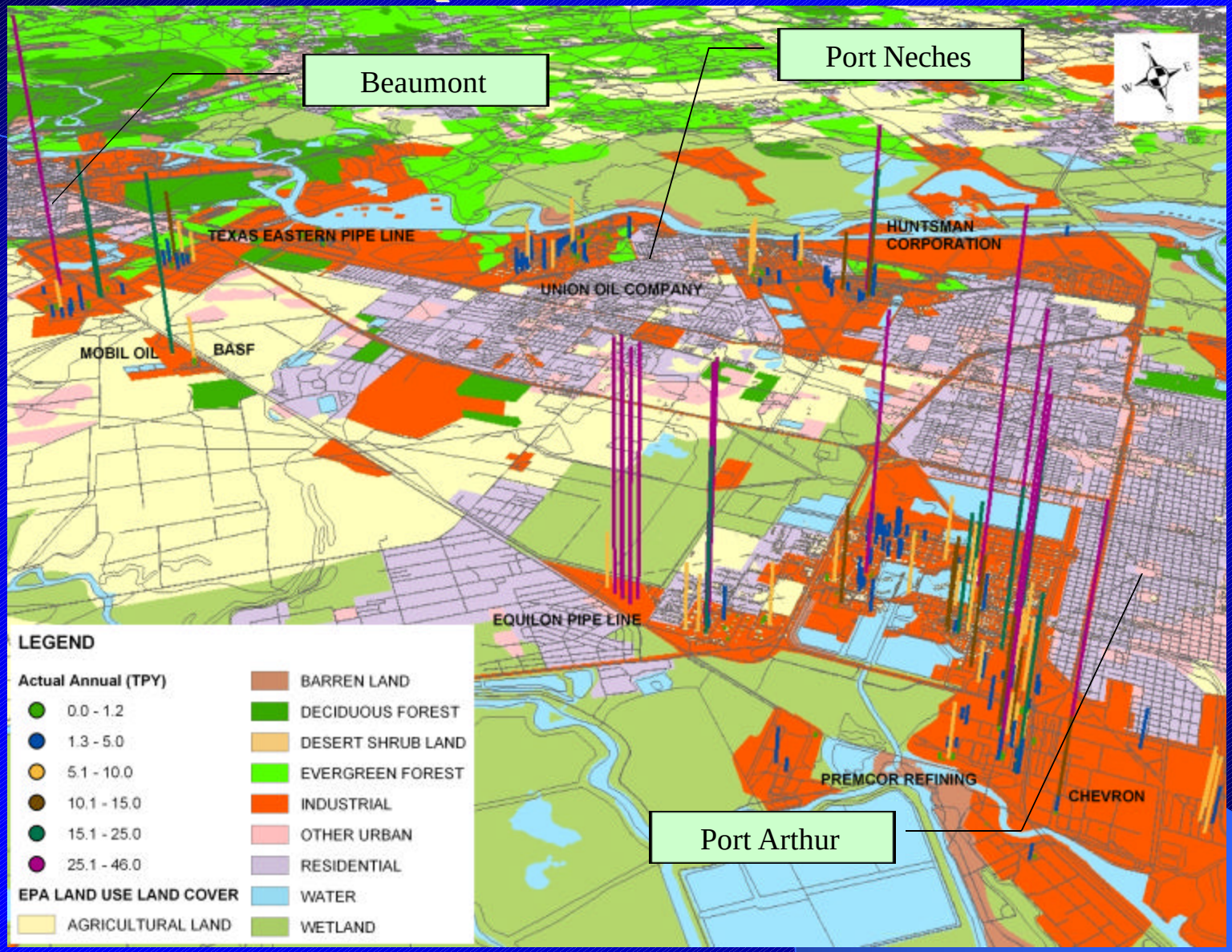








Data Miner – Emissions analysis tool developed as part of RAIMI



3D Representation of Emissions

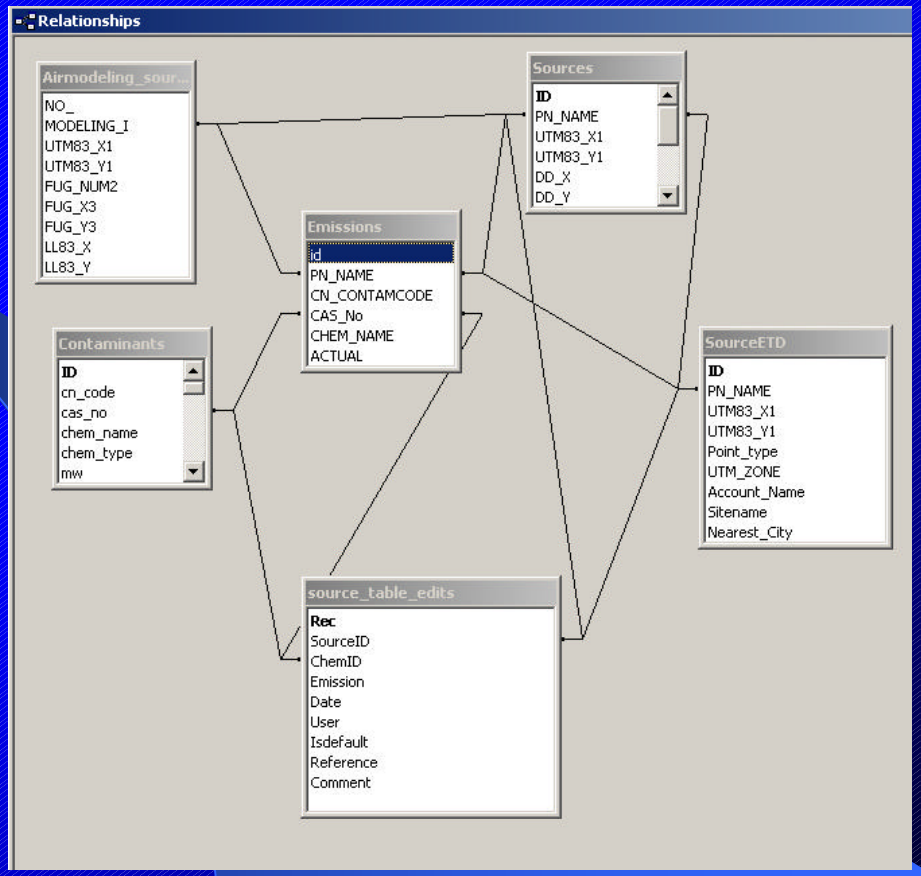
Jefferson County, Texas – Non-Methane VOCs

RAIMI COMPONENTS

Emissions Characterization Component Cont.,

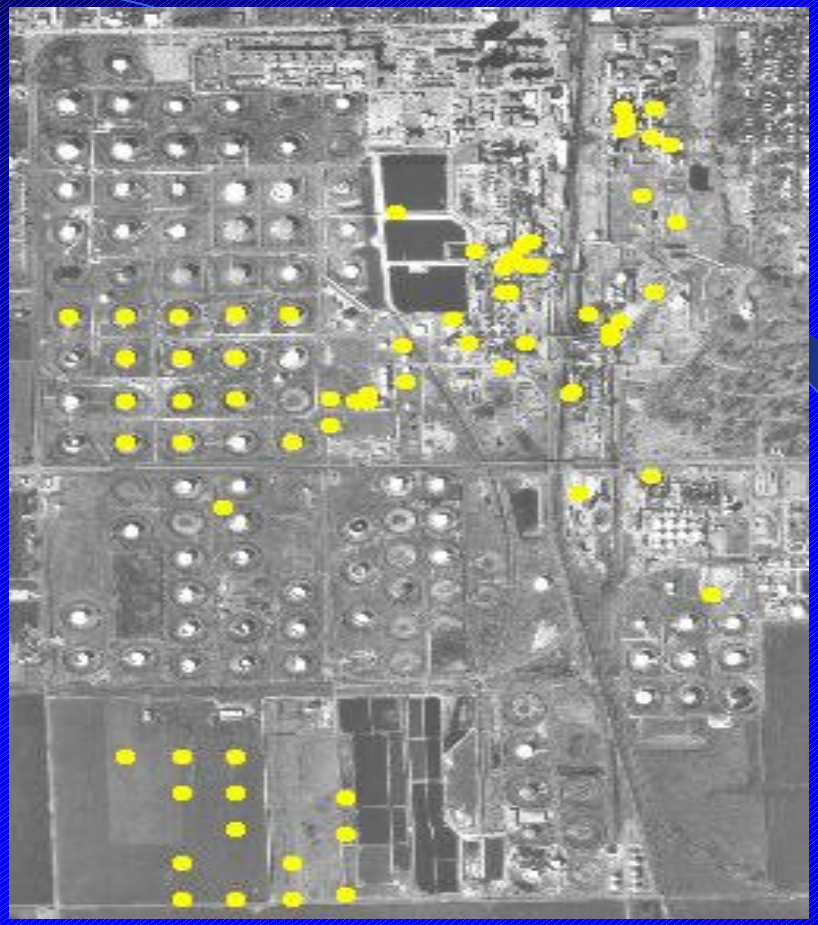
ETD: Emissions Tracking Database

- String of inter-linked database tables
- Database structure and functionality designed to support cumulative-type assessments requiring large capacity and high resolution of results for solution management

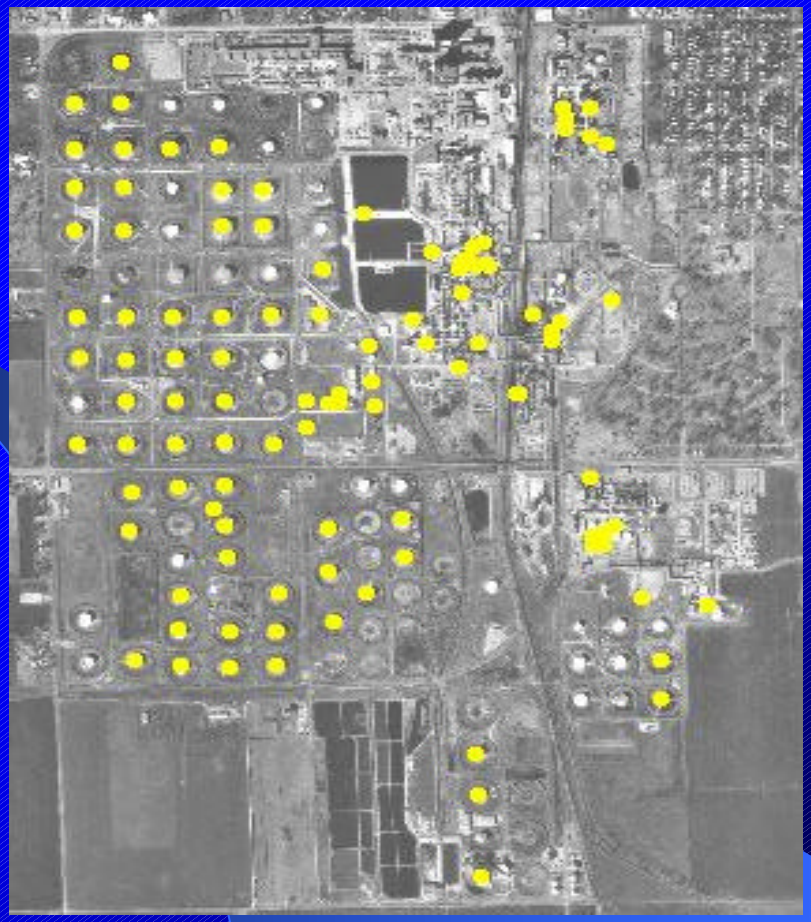


Geo-location

Emissions Characterization Component



UTM NAD 27 Locations – Incorrect!



UTM NAD 83 Locations – Correct!

AIR MODELING

Selection Criteria for Air Model

Comparison of Model Capabilities:

	ASPEN	ISCST3	AERMOD	CALPUFF
Source types	**Sufficient**	**Sufficient**	**Sufficient**	**Extensive**
Grid node coverage	**Sufficient (t = 1)**	**Sufficient (t = 10^2)**	**Sufficient (t = 10^2)**	**Sufficient (t = 10^3-10^4)**
Site features	*Minimal*	**Sufficient**	**Sufficient**	**Extensive**
Weather variations	*Minimal (single site – annual)*	**Sufficient (single site – hourly)**	**Sufficient (single site – hourly)**	**Extensive (multi site – hourly)**
Complex processes	*Minimal (factoring)*	**Sufficient (all processes)**	*Minimal (no deposition)*	**Extensive (all processes)**
Widely accepted	*Minimal (regulatory)*	**Extensive (20+ years)**	*Minimal (new model)*	**Sufficient (proprietary)**

RAIMI COMPONENTS

Air Modeling Component

- **"Single-pass"** air modeling for each source
  - Provides all necessary air modeling data to support current and anticipated future risk modeling needs
  - **"Unit emission rate"** enables one set of model runs for modeling each emission source to accommodate any combination of emissions scenarios (such as reported actual emissions, permitted allowable emissions, revised quantities of emissions due to operational changes, or inclusion of new contaminants in the emissions profile)
  - **"Emissions partitioning"** provides phase-specific modeling runs (vapor, particle, particle-bound, mercury)

RAIMI COMPONENTS

Air Modeling Component

Applies "Universal Grid"

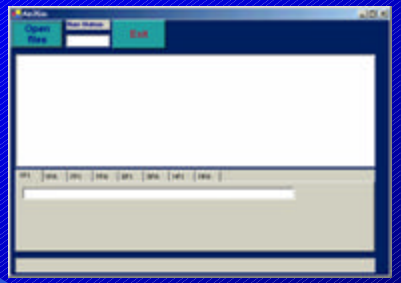
- **Standardized** Geographic Coordinate System - all data is stored in **NAD 83 Latitude/Longitude curvilinear**.
- As needed by applications, data is projected into required coordinate system (air model component is performed in UTM rectilinear coordinates, and results are presented in UTM)
- **Point-to-Point Alignment** of Calculation Nodes - all grid nodes in the source-specific air model runs are specified at a 3-arc-second intersection to avoid data interpolation

RAIMI COMPONENTS

Air Modeling Component

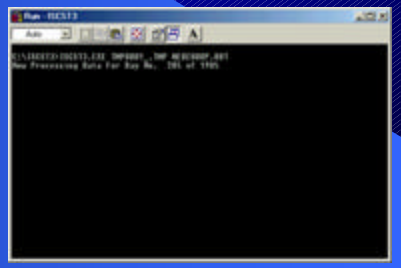
AMP (Site Characterization Tool)

- Processes source specific site parameters
- Create air model input files
- Creates universal grid with terrain elevations surrounding each source
- Processes Met files using EPA's Meteorological Processor for Regulatory Models (MPRM)



AIR2GIS

- Converts air modeling plot files for import into GIS platform



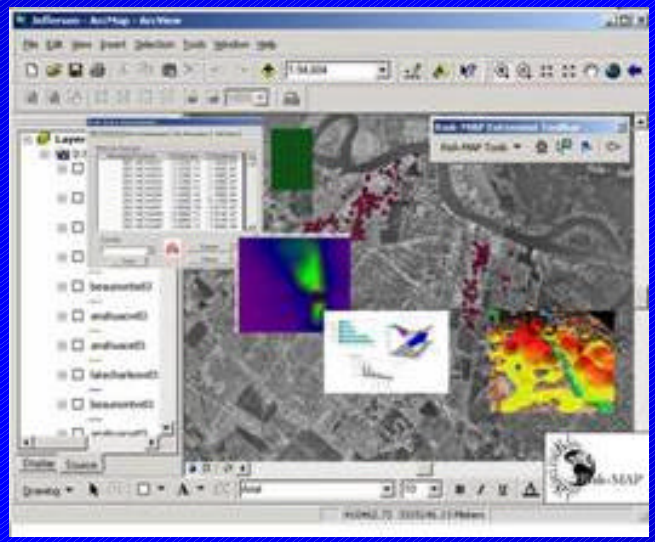
Air Dispersion Model (ISCST3, AERMOD, CALPUFF)

RISK MODELING

Selection Criteria for Risk Model - Comparison of Model Capabilities

	EMS-HAPs	NATA	RAIMI (Risk-MAP)	HARP	RSEI
Open Architecture	--	--	✓	--	--
Localized/National	Intermediate	National	Localized	Localized	National
Resolution	Urban Area	County	Community	--	--
Attribution	--	Source-specific	Source-specific	--	Facility
GIS-Based	✓	✓	✓	✓	✓
Supports Solutions Management	--	--	✓	--	--
Micro-exposure	--	✓	--	--	✓
Population Data	Census	Census CHAD	Census LandScan	Census	Census
Author	EPA	EPA – OAQPS	EPA – Region 6	CAL – EPA	EPA

RAIMI COMPONENTS

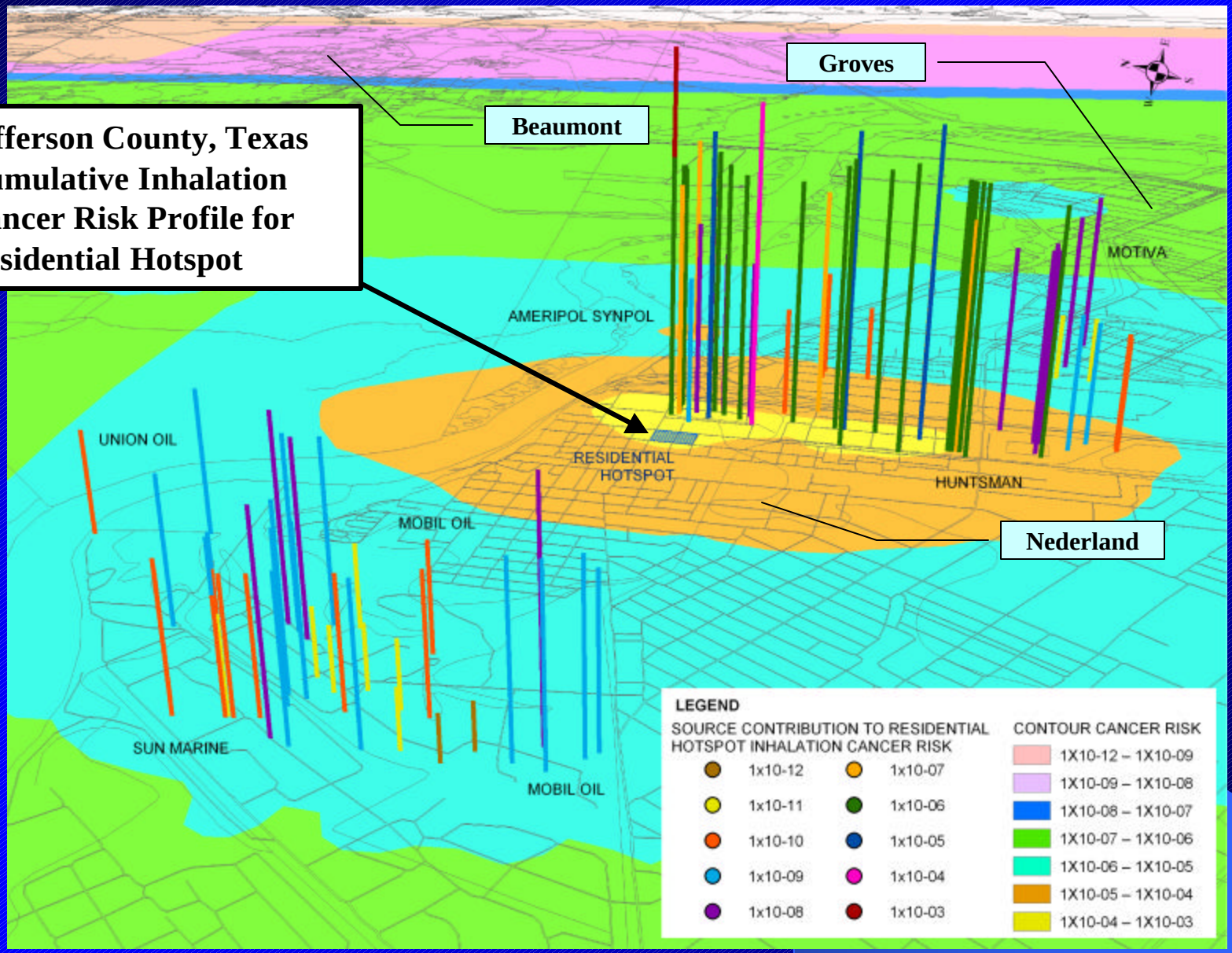


Risk Modeling Component –

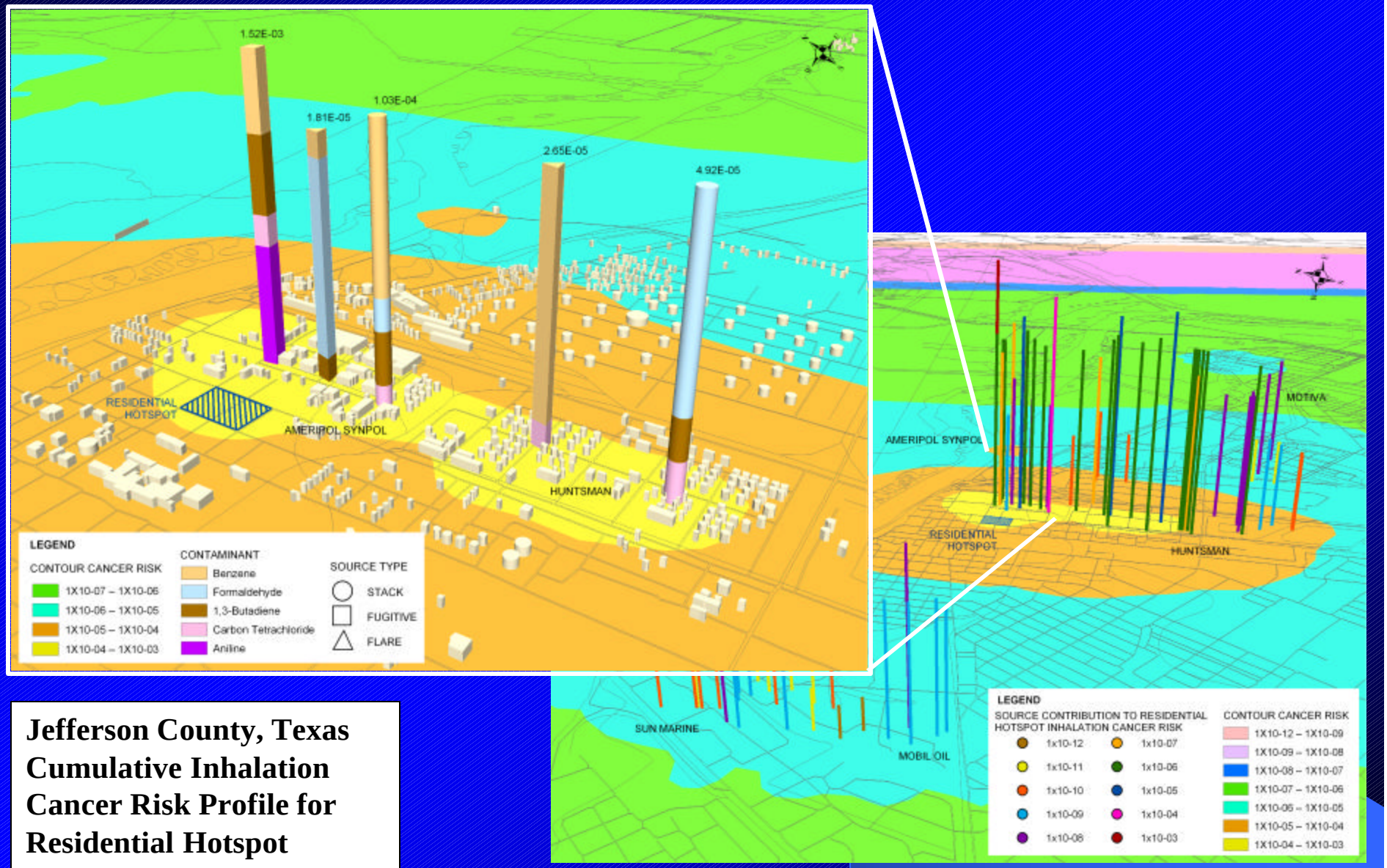
Risk-MAP

- Risk-modeling module that work as an extension for ArcView 8.3.
- Capitalizes on the project management, data-analysis and presentation functions currently integrated into the ArcView GIS platform
- Calculates exposure pathway specific values in a spatially layered data environment
- Supports capacities typically required of cumulative type studies
- Offers custom visual displaying of interim and final results in traditional (tabular, etc.) and mapped (isopleths, spatial attributes, attribution tracking, etc.) formats to support solution consideration, implementation, and tracking

Cumulative Cancer Risk Contours with Source Specific Attribution Profile for Residential Hotspot



Cumulative Cancer Risk Contours with Source Specific Attribution Profile for Residential Hotspot - (Zoom)



Jefferson County, Texas Cumulative Inhalation Cancer Risk Profile for Residential Hotspot

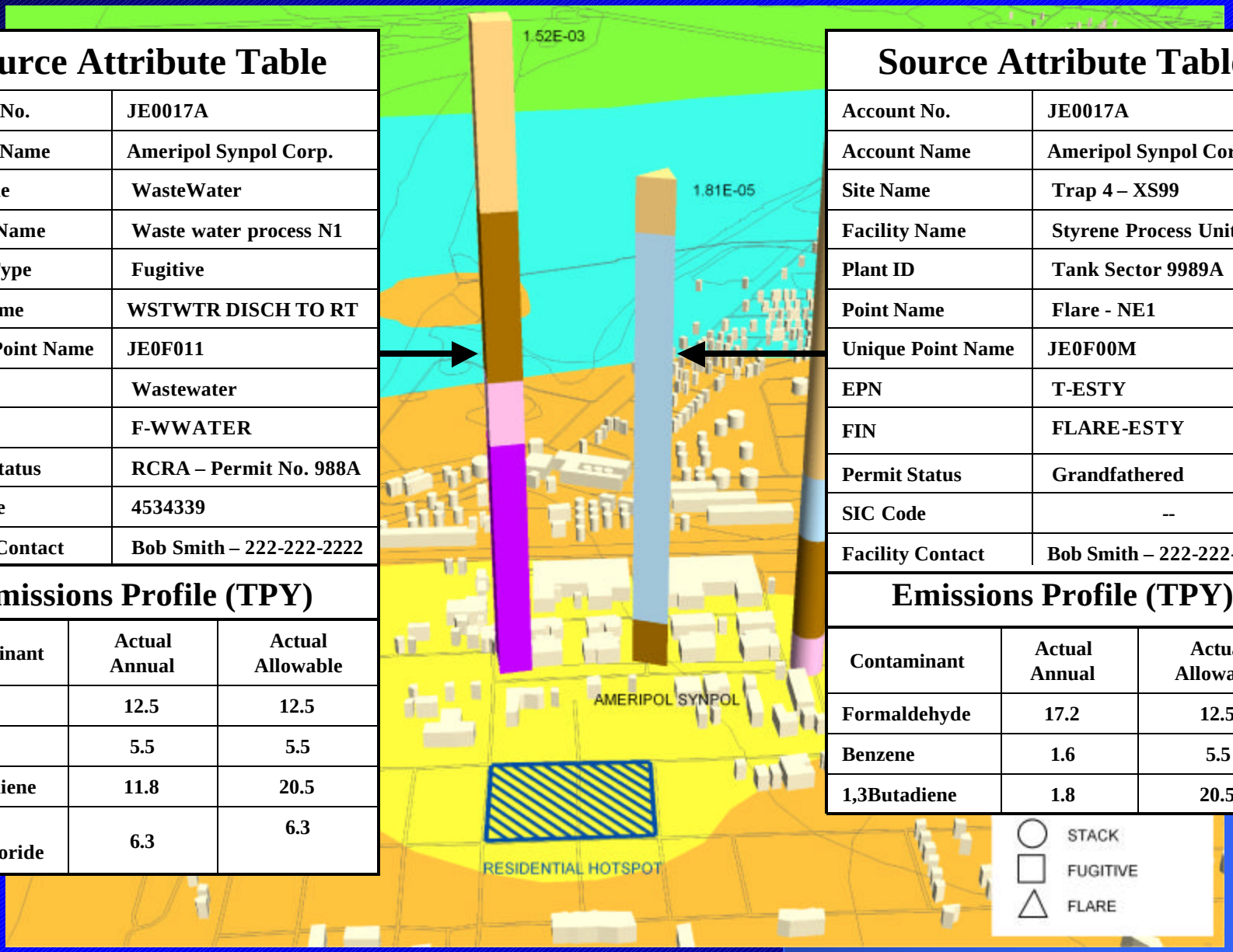
Source Attributes for Conducting Legal Review to Support Solutions Management

Source Attribute Table

Account No.	JE0017A
Account Name	Ameripol Synpol Corp.
Site Name	WasteWater
Facility Name	Waste water process N1
Source Type	Fugitive
Point Name	WSTWTR DISCH TO RT
Unique Point Name	JE0F011
EPN	Wastewater
FIN	F-WWATER
Permit Status	RCRA – Permit No. 988A
SIC Code	4534339
Facility Contact	Bob Smith – 222-222-2222

Emissions Profile (TPY)

Contaminant	Actual Annual	Actual Allowable
Aniline	12.5	12.5
Benzene	5.5	5.5
1,3Butadiene	11.8	20.5
Carbon Tetrachloride	6.3	6.3



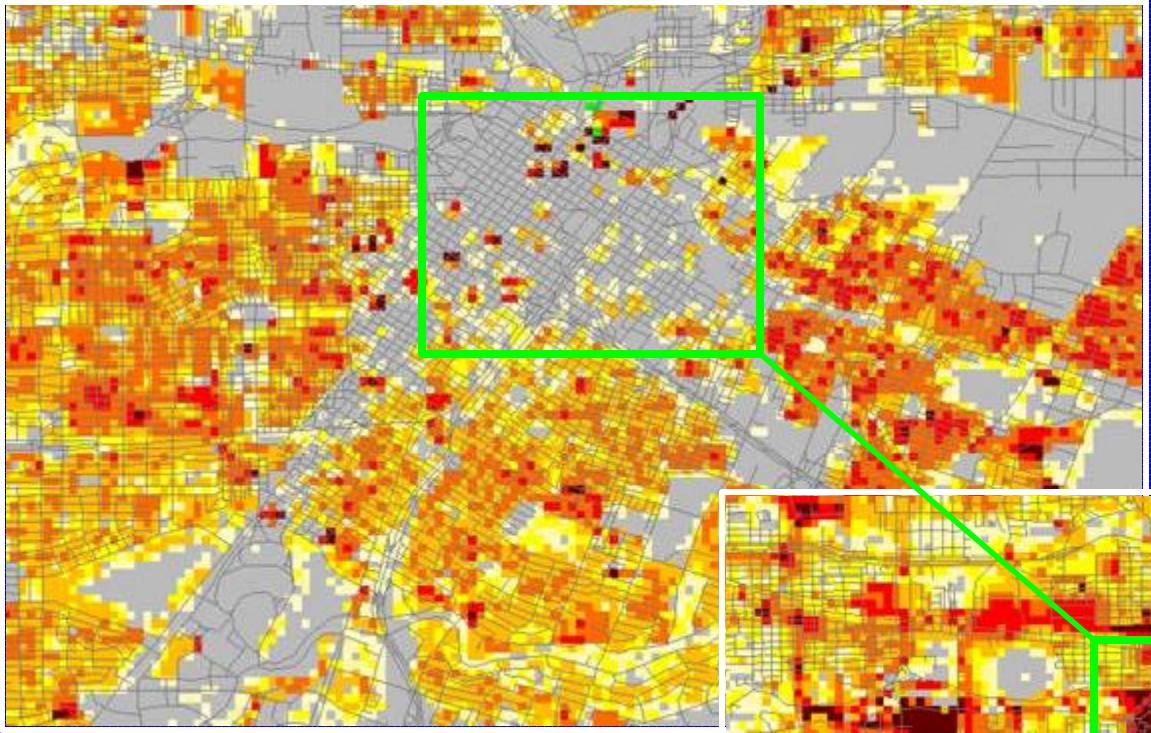
Source Attribute Table

Account No.	JE0017A
Account Name	Ameripol Synpol Corp.
Site Name	Trap 4 – XS99
Facility Name	Styrene Process Unit
Plant ID	Tank Sector 9989A
Point Name	Flare - NE1
Unique Point Name	JE0F00M
EPN	T-ESTY
FIN	FLARE-ESTY
Permit Status	Grandfathered
SIC Code	--
Facility Contact	Bob Smith – 222-222-2222

Emissions Profile (TPY)

Contaminant	Actual Annual	Actual Allowable
Formaldehyde	17.2	12.5
Benzene	1.6	5.5
1,3Butadiene	1.8	20.5

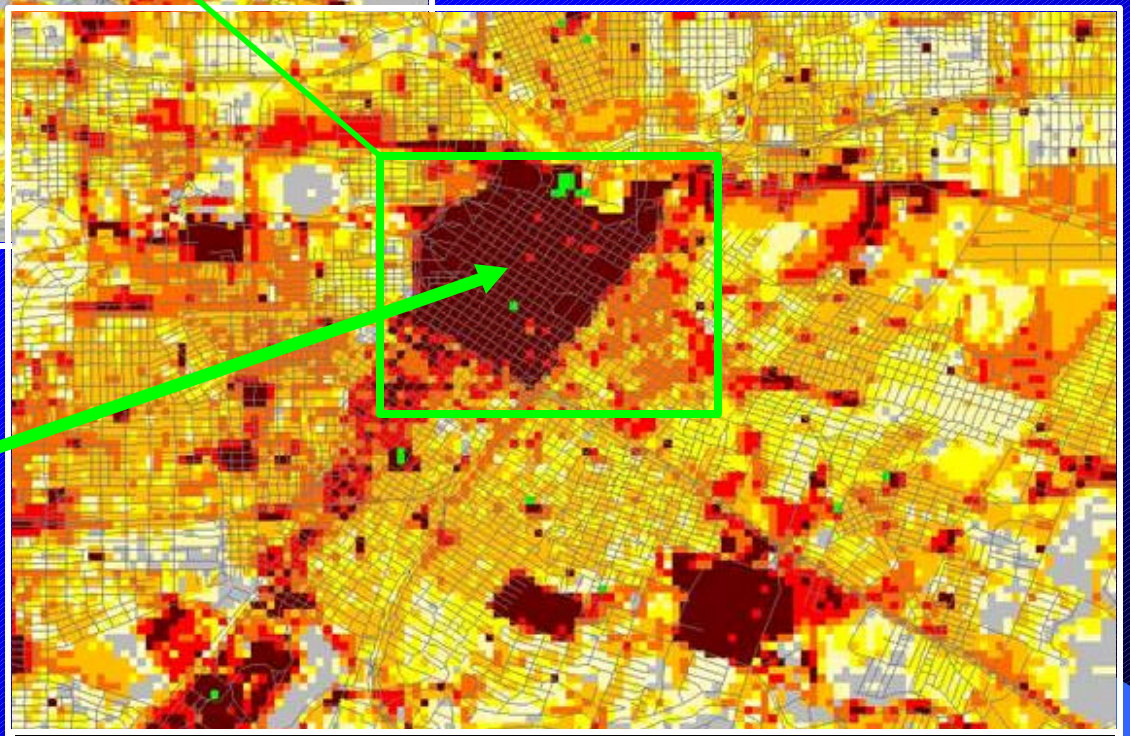
Nighttime Population Distribution



Land Scan USA Population Data

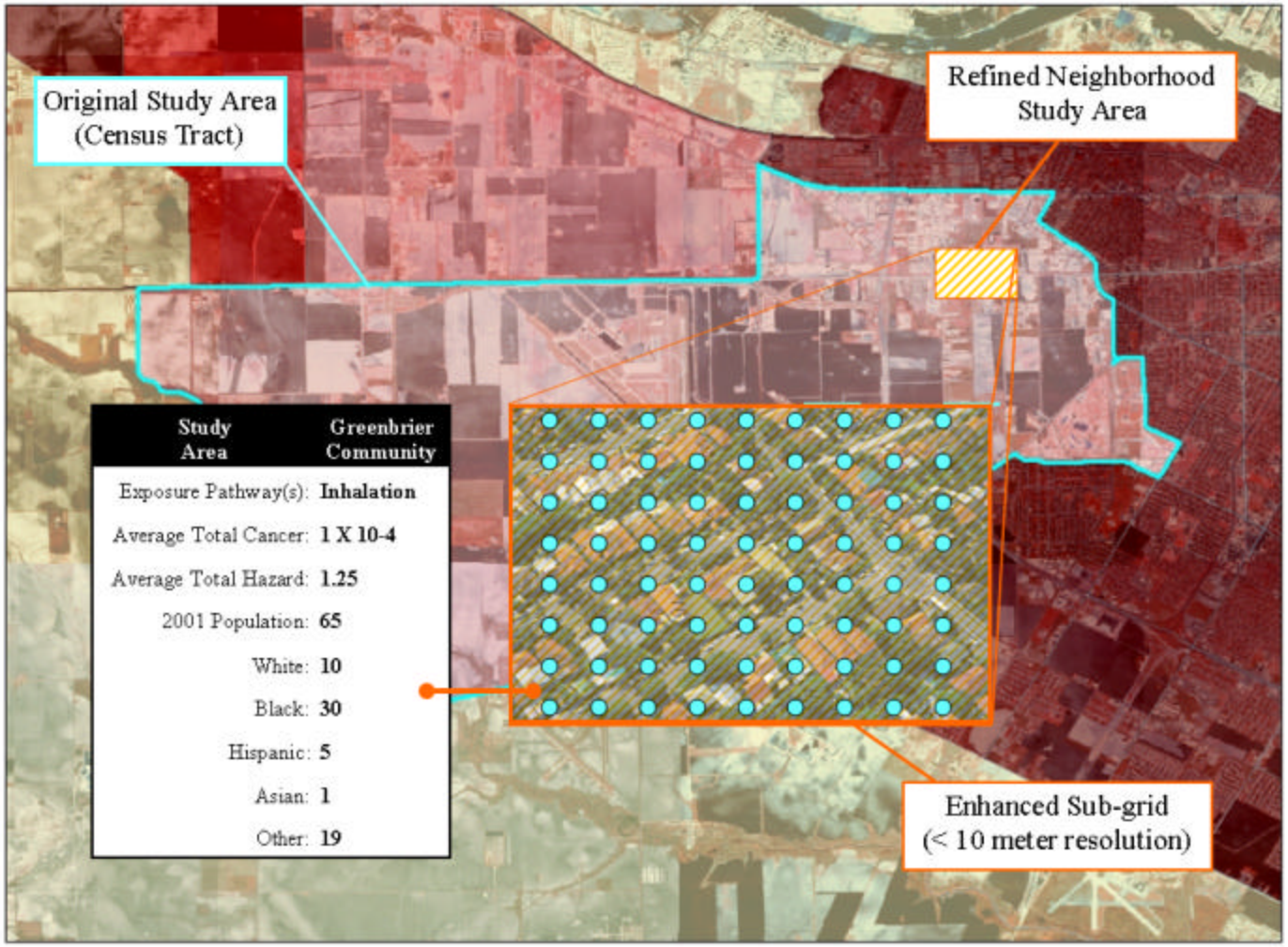
Diurnal population distribution is critical to understanding the localized nature of exposure.

More than 160,000 people occupy this downtown tract during a typical workday. The same area is almost deserted during nighttime hours.



Daytime Population Distribution

Population and Risk Averaging



RAIMI – Solutions Management and Tracking Component

- ***Prioritize Sources*** – Select source type, contaminant, neighborhood, facility
- ***Verification*** – Verify Source location, emission profile, toxicity factors
- ***Refinement*** – Identify data gaps, secondary formation, bounding analysis
- ***Legal Review*** – Determine permit status, source status, operating conditions

RAIMI – Solutions Management and Tracking Component, Cont.

- ***Facility Involvement*** – Solicit facility data, cooperative agreement
- ***Identify Risk Management Options*** – Determine acceptable risk levels, review options
- ***Implement and Track Solution and Outcomes*** – Perform trending analysis, support GPRA goals